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## ORIGINAL ARTICLES

### Surveillance report

# A NATIONAL SYNDROMIC SURVEILLANCE SYSTEM FOR ENGLAND AND WALES USING CALLS TO A TELEPHONE HELPLINE

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Routine primary care data provide the means to monitor a variety of syndromes which could give early warning of health protection issues. In the United Kingdom, a national syndromic surveillance system, operated jointly by the UK Health Protection Agency (HPA) and NHS Direct (a national telephone health helpline), examines symptoms reported to NHS Direct. The aim of the system is to identify an increase in syndromes indicative of common infections and diseases, or the early stages of illness caused by the deliberate release of a biological or chemical agent. Data relating to 11 key symptoms/syndromes are received electronically from all 22 NHS Direct call centres covering England and Wales and analysed by the HPA on a daily basis. Statistically significant excesses in calls are automatically highlighted and assessed by a multi-disciplinary team. Although the surveillance system has characterised many sudden rises in syndromes reported to NHS Direct, no evidence of a biological or chemical attack has been detected. Benefits of this work, however, are early warning and tracking of rises in community morbidity (e.g. influenza-like illness, heatstroke); providing reassurance during times of perceived high risk (e.g. after

the 7 July 2005 London bombs and December 2005 Buncefield oil depot fire); and timely surveillance data for influenza pandemic planning and epidemic modeling.

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**Key words:** NHS Direct, syndromic, surveillance, influenza

## Introduction

Routine primary care data provide the means to monitor a variety of syndromes which could give early warning of health protection issues (microbiological, chemical, or radiological). Milder illnesses which patients may not present with at hospitals (e.g. conjunctivitis) or illnesses for which laboratory specimens are not routinely taken (e.g. influenza-like illness (ILI)) can be tracked. Real time data are needed to respond to major health protection incidents. In recent years there has been a growth in the number of telephone triage systems that provide the public with health advice and information. This article describes a real time national syndromic surveillance system covering England and Wales, using data about symptoms reported to a national telephone helpline (NHS Direct [1]).

## NHS Direct

NHS Direct is a nurse-led health helpline that provides the population of England and Wales with rapid access to health advice

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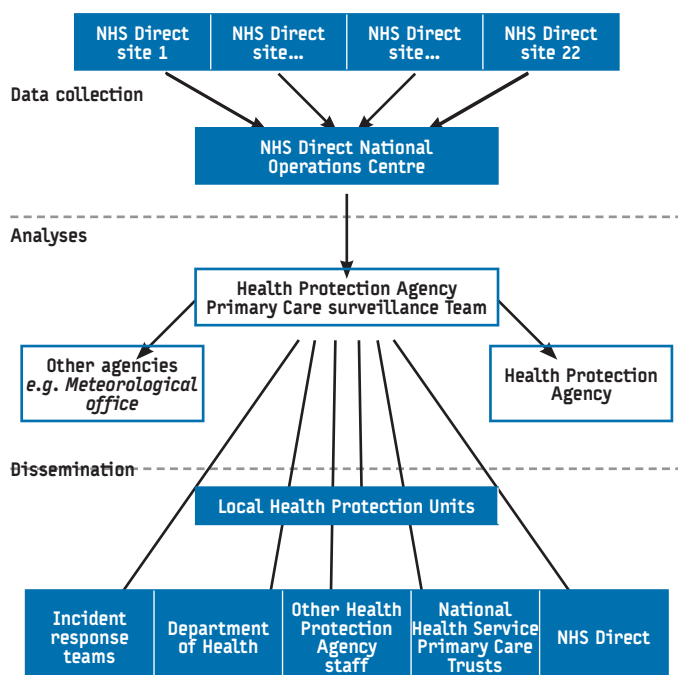
and information about health, illness, and the National Health Service (NHS). The service operates 365 days per year from a network of 21 sites in England and a single site covering all of Wales, is the world's largest online provider of healthcare advice, and answers nearly 7 million calls per year. NHS Direct nurses use clinical decision support software (the NHS Clinical Assessment System (NHS CAS)) to respond to callers. The NHS CAS is structured around 230 computerised clinical algorithms (such as diarrhoea, fever and back pain). Approximately 30% of NHS Direct calls are requests for health information, and 70% of calls are to report symptoms. The nature and severity of the reported symptoms dictate which algorithm is selected by the nurse and, ultimately, which outcome is recommended (these include advice for self care (19% of total calls); family doctor referral (51%); referral to accident and emergency department of a hospital (8%); '999' emergency call (either made by the caller or from NHS Direct) both depending on the seriousness (5%); or other services (17%). Abdominal pain, vomiting, toothache, fever, chest pain, diarrhoea, headache and sore throat collectively account for 30% of total symptomatic calls made to NHS Direct.

#### Who use NHS Direct?

Approximately 25% of the population of England have used NHS Direct [2], although the total call rate is approximately 3% of the total consultation rate for primary care doctors [3]. The highest NHS Direct call rates are for young children (calls about symptoms: <1 year: 358 calls per 1000 per year; 1-4 years: 173 per 1000 during 2005; 15-44 years: 76 per 1000), and the lowest for those over 65 years. Women are more likely than men to use the service: the ratio of female to male calls is 1.3:1. This age-sex distribution is largely comparable to consultations for primary care doctors, with the exception of the low NHS Direct call rate from those over 65 years. With respect to sociodemographic background of NHS Direct callers, ecological studies suggest call rates rise with increasing social deprivation before falling in the most deprived areas [4, 5]. The proportion of callers from different ethnic groups mirrors the census population, with the exception of under representation from the Chinese population sub-group [personal communication, Frances Chinemana, NHS].

FIGURE 1

#### NHS Direct / Health protection agency syndromic surveillance flow chart



#### NHS Direct/HPA syndromic surveillance system

The Health Protection Agency (HPA) is an independent body that protects the health and wellbeing of the population. The Agency plays a critical role in protecting people from infectious diseases and in preventing harm when hazards involving chemicals, poisons or radiation occur [6]. In recent years there has been an increase in syndromic surveillance systems that analyse non-specific or pre-diagnostic data to detect changes or trends in the health of a population, particularly in the United States [7, 8]. NHS Direct and the HPA run a syndromic surveillance system to enable country-wide monitoring and identification of an increase in calls about 'key symptoms' reported to NHS Direct. The aim of the system is to identify an increase in syndromes indicative of common infections and diseases, or the early stages of illness caused by the deliberate release of a biological or chemical agent [9].

#### Method

##### Transfer of data

Daily call data relating to 11 algorithm groupings (syndromes) and numbers of total calls, are received electronically by the HPA for all 22 NHS Direct sites in England and Wales each weekday [FIGURE 1]. Syndromes were selected [TABLE] which may be indicative of infections or illnesses resulting from chemical exposure, or the early stages of a range of illnesses caused by the deliberate release of biological or chemical agents. Data are broken down by NHS Direct site, syndrome, age group and call outcome.

##### Statistical analysis

Upper confidence limits (99.5% level) of calls for each syndrome, as a proportion of daily total calls, are constructed each weekday for each NHS Direct site. These confidence limits are derived from standard formula for proportions [10] with the baseline numbers of total calls and symptom calls adjusted for seasonal effects (monthly adjustment).

In addition to the confidence interval analyses, control charts are constructed for six of the eleven syndromes (cold/flu, cough, fever, difficulty breathing, diarrhoea, and vomiting) at the 10 NHS Direct sites covering major conurbations in England. Baselines for the control charts are calculated by assuming the number of syndromic calls follow a Poisson distribution. Total calls are used as an offset. A model is fitted

TABLE

Eleven syndromes monitored by the NHS Direct syndromic surveillance system; number of calls and proportion of total calls recorded by the surveillance system, England and Wales, 2005

| Syndrome                                          | Calls          | Calls as a proportion of total calls |
|---------------------------------------------------|----------------|--------------------------------------|
| Cold/flu                                          | 32 462         | 0.8%                                 |
| Cough                                             | 105 740        | 2.5%                                 |
| Diarrhoea                                         | 119 399        | 2.8%                                 |
| Difficulty breathing                              | 49 205         | 1.2%                                 |
| Double vision                                     | 371            | 0.01%                                |
| Eye problems                                      | 42 613         | 1.0%                                 |
| Fever                                             | 133 761        | 3.2%                                 |
| Heat/sunstroke<br>[only monitored June-September] | 947            | 0.03%                                |
| Lumps                                             | 31 754         | 0.8%                                 |
| Rash                                              | 170 202        | 4.1%                                 |
| Vomiting                                          | 164 742        | 3.9%                                 |
| <b>Total</b>                                      | <b>851 196</b> | <b>20.3%</b>                         |

to each site and syndrome separately using data from December 2001 onwards. These models always contain a public holiday and seasonal term, and if shown to be necessary, a day of the week (weekday, Saturday or Sunday) and a linear long term trend factor. Scaling is performed to account for over-dispersion when present.

#### Investigating rises in calls ('exceedances' and 'alerts')

Statistically significant excesses (termed 'stage 1 exceedances') in calls for any of the eleven syndromes are automatically highlighted and investigated further if the on-call project scientist considers they represent a potential threat. The scientist considers issues including: obvious data errors; single or multiple day 'exceedances'; and the proportion of calls where emergency care has been recommended by NHS Direct nurses.

If no reasonable explanation can be found for the 'exceedance', additional call details are requested, and this is termed a 'stage 2 investigation'. Factors that influence whether to progress from a stage 1 exceedance at an NHS Direct site to a stage 2 exceedance are:

- Call activity at adjacent NHS Direct sites
- Call activity in other syndromes
- The degree of statistical excess
- Call outcomes ('dispositions')
- Whether it is a 1 day or >1day exceedance
- Intelligence from other surveillance systems, colleagues, or the media

The current day's data, if available, are used to determine whether the high level of calls has persisted for a particular syndrome. A geographical information system (GIS) may be used to map calls for obvious clustering. When the scientist considers that the information provided by the 'stage 2 investigation' necessitates further action (potentially due to geographical clustering or persistently high level of calls), this is discussed with the on-call project consultant epidemiologist and NHS Direct medical advisor.

If it is considered to be warranted, a 'stage 3 alert' is issued and may result in reports being disseminated to local public health teams (e.g. HPA Health Protection Units) and national coordinators (e.g. for influenza surveillance), or the NHS Direct on-call medical

adviser contacting callers to obtain further clinical information. When this type of action is taken, local or national agencies are normally informed within 24-48 hours of the NHS Direct calls being made. Although a mechanism to provide self-testing kits to NHS Direct callers in order to obtain diagnostic specimens for influenza testing has been developed [11], this procedure is not routine.

#### Routine outputs

As well as the ad hoc stage 3 alerts, weekly bulletins that summarise NHS Direct call activity for all 11 syndromes are emailed to local and national health protection teams, NHS Direct sites, and the NHS every Wednesday. These bulletins and additional surveillance data are also published on the HPA website [12].

#### Results

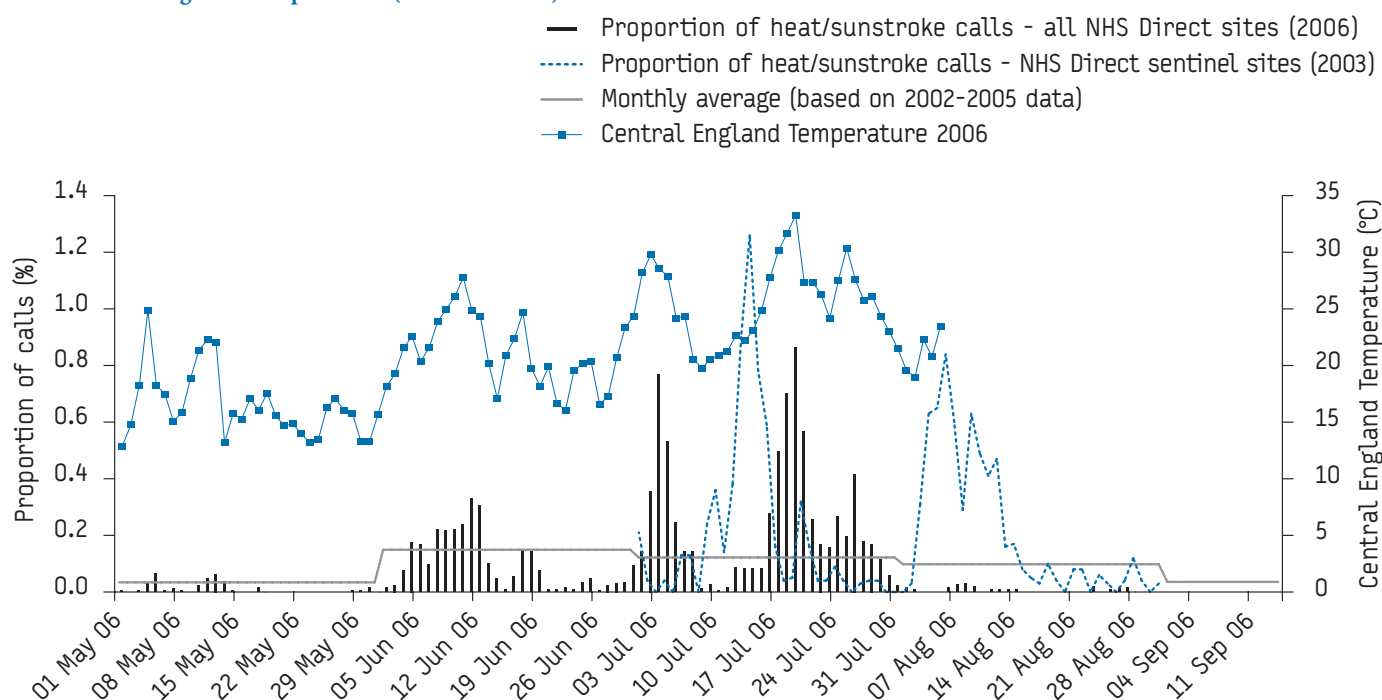
Obtaining precise measures of sensitivity for our system is difficult as there is no agreed 'gold standard' against which to compare our results. It has been shown retrospectively that NHS Direct cold/flu calls show a weak correlation with consultations for ILI recorded by the Royal College of General Practitioners Weekly Returns Service [13]. Prospectively, the NHS Direct syndromic surveillance system generates many stage 1 exceedances, of which most are not investigated. For example, during March 2004 to February 2005, there were 158 single site control chart exceedances. Twenty three (14.6%) of these progressed to a stage 2 investigation and 3 (1.9%) to a stage 3 alert. The alerts highlighted separate rises in calls about diarrhoea and difficulty breathing, of which no cause could be found, and no further action was taken. The third alert was a rise in cold/flu calls during December 2004, occurring concurrently at separate NHS Direct sites, which heralded a seasonal rise in influenza and ILI detected by other surveillance systems over the following weeks.

#### How has the syndromic surveillance system helped?

Although established as an incident / outbreak detection system, as the work has evolved further utilities of the surveillance outputs have emerged. Examples of how the data have been used are given below.

FIGURE 2

Daily NHS Direct 'heat/sunstroke' calls as a proportion of total calls summer 2006 and 2003, monthly average (2003-2005), and Central England temperature (summer 2006)



### Early warning of rises in disease

NHS Direct syndromic data are used as part of the national influenza surveillance programme. For example, during January 2006 there was a sudden increase in school outbreaks of influenza B [14] and media concern that schools in the West Midlands were particularly affected. The reporting of school outbreaks is not consistent across the country, however, so it was necessary to carefully examine the various sources of available surveillance data.

On 25 January 2006 the weekly NHS Direct syndromic surveillance bulletin reported a significant national rise in the proportion of NHS Direct 'fever' calls for the 5-14 year age group. At the same time clinical and laboratory indicators of influenza remained relatively low. Regional trends indicated that fever calls in the West Midlands were high (peaking at 14.4% of total calls), but not significantly higher than the rest of the country (national peak 13.5%).

In this instance NHS Direct syndromic surveillance data were able to provide an early indication of a community rise of fever in school aged children (a proxy for ILI), confirmation that this rise was not specific to the West Midlands (quelling media fears), and ongoing regional specific surveillance data (along with other primary care surveillance systems) for the remainder of the national outbreak.

### Verification of community morbidity

NHS Direct calls about 'heat and sunstroke' have been used as part of the Department of Health Heat Health watch plan for England [15] in order to monitor the health impact of heatwaves, for example during July 2006 when a heatwave affected large parts of Europe.

Between 1 May and 15 September 2006 the daily numbers of heat/sunstroke calls were monitored, broken down by NHS Direct site (22 in total), age group (0-4, 5-74,  $\geq 75$  years) and call outcome (999 call out, A&E referral, GP referral, home care advice, other). During this time 1474 heat/sunstroke calls were received by NHS Direct in England and Wales out of 1 739 768 total symptomatic calls (0.08%). There were four distinct peaks in heat/sunstroke calls, as a proportion of total calls, on 11 June (52 calls, 0.3%), 3 July (109 calls, 0.8%), 19 July (115 calls, 0.9%) and 26 July (26 calls, 0.4%). These four peaks occurred on the same day or one day after peaks in the Central England Temperature [FIGURE 2]. Over the summer all NHS Direct sites handled heat/sunstroke calls, with the highest proportions of calls being received in Wales (80 calls, 0.11%), the West Midlands (162 calls, 0.11%) and the South East (297 calls, 0.10) regions. The 5-74 year age group accounted for 1299 heat/sunstroke calls (89% of total).

Throughout the summer trends in heat/sunstroke calls were summarised in the weekly NHS Direct syndromic surveillance bulletin. During the two periods in which high temperatures triggered 'heat-health' response levels 'Alert' and 'Heatwave', daily NHS Direct heat/sunstroke bulletins (4-5 July, 17-28 July) were issued to the Department of Health and other agencies involved in implementing the heatwave plan.

NHS Direct call data were the only real time health data available during the heatwave and a timely measure of increased community morbidity due to heat. The relatively low numbers of heat/sunstroke calls (1 74 during the summer) may indicate that these data were important as a prompt signal for detecting health effects, rather than as a mechanism for quantifying such effects.

### Reassurance

'Real time' data have been used to provide reassurance about the lack of health impact following major incidents (e.g. after the traces of ricin were found in a London flat in January 2003; after the London bombs of 7 July 2005). This was helped by ability to report on data more frequently than daily (for special circumstances), and by mapping NHS Direct calls.

Most recently, on 11 December 2005 there was a huge explosion at the Buncefield fuel depot in southern England [16]. Twenty oil tanks were destroyed in one of the largest blasts in peacetime Europe. In the immediate aftermath of the blast, and for the following six weeks, total NHS Direct calls, calls about 'breathing problems' and 'cough' and the outcomes of NHS Direct respiratory calls were monitored for the eight NHS Direct sites covering the potentially effected area. Although increases in respiratory calls were detected at local NHS Direct sites during December/January 2006, these rises were considered normal for the winter period and no increases in calls thought to be due to the blast were observed. The data, with accompanying interpretation, were used to provide reassurance to the incident team about a lack of an unusual increase in clinical illness and to provide reassurance for the public.

### Emergency planning and exercises

The systematic collection of almost five years worth of daily national call data, with well established statistical baselines, means the surveillance database is now a well used resource, providing data extracts for emergency planning exercises and modeling work, particularly around pandemic influenza.

### Evaluation

A preliminary evaluation of the NHS Direct syndromic surveillance system in 2004 using the 'Framework for Evaluating Public Health Surveillance Systems for Early Detection of Outbreaks' [17] concluded that the system was timely, representative and useful [13]. The direct annual operating cost of the system (£150 000 per annum or around €224 000) was considered to be low for a national surveillance system. This value did not include data costs, however, as the surveillance requirements of the system are embedded into the core operations of NHS Direct.

### Discussion

The NHS Direct syndromic surveillance system has been used several times to reassure public health teams and the public about the lack of major impact of a health protection incident. We are still not sure, however, (for differing syndromes) what increase in calls would occur for unexpected health protection incidents. The evaluation [13] found that the system was more likely to detect large scale events or generalised rise in syndromes than localised outbreaks of communicable disease. This is supported by the early warning of ILI detected during January 2006 and rapid detection of heat related illness during July 2006. The opportunity to detect very localised rises in illness (potential outbreaks) may improve as NHS Direct call rates rise over time and the statistical methodology used to flag local data anomalies is refined (e.g. using integrated spatio-temporal analysis tools).

The total NHS Direct call rate is low when compared to the total consultation rate for family doctors (approximately one thirtieth the rate). Therefore, even though NHS Direct has national coverage, the system captures only a small proportion of illness reported to primary care in England and Wales. Our system is designed to monitor acute symptoms which may be indicative of a health protection incident, and are mainly respiratory and gastrointestinal in nature. The system uses routinely generated data and does not require the NHS Direct nurses to enter additional information, thus causing minimal disruption to the work patterns of the data providers. The algorithms used are those collected routinely for telephone triage purposes and the surveillance team have been 'pragmatic' about lack of clear case definitions. However, although there was initial scepticism about what, for example, the 'cold/flu' algorithm may be measuring, good accordance with generalised ILI activity has been noted [17, 18].

The surveillance team (NHS Direct and HPA) that operate the

surveillance system believe it is helpful to have a clear and working link between themselves, and those conducting any resulting public health response (e.g. local HPA Health Protection Units). Future challenges for are the provision of local surveillance data to a newly defined network of Primary Care Trusts in England and Wales, integrating routine spatio-temporal analyses into the surveillance system, and further evaluation of the usefulness of the surveillance system for public health practitioners.

### Conclusions

Although syndromic surveillance systems based on data from regional *telephone* triage systems exist, the use of data from a national telephone health help line (NHS Direct) is unique in the field of syndromic surveillance. The NHS Direct syndromic surveillance system is also the only national daily surveillance system in UK and provides a timely national snapshot of community morbidity for selected symptoms. To date, no deliberate release of either chemical or biological agents has been detected. The main benefits of using NHS Direct telephone triage data for public health surveillance have been in providing early warning of rises in infectious disease and disease caused by environmental factors, tracking and verification of trends in community morbidity, and reassurance that widespread disease is not occurring when there is a perceived high public health risk.

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